CLAIMS

What is claimed is:

1. A water heater comprising:

a water tank;

a combustion chamber having a thermal relation to the water tank; and

a gas heating element disposed in the combustion chamber, the gas heating element including a first combustive section and a second combustive section separately controlled from the first combustive section.

2. A water heater as set forth in claim 1 wherein the first combustive section comprises a first gas burner and the second combustive section comprises a second gas burner.

3. A water heater as set forth in claim 1 wherein the gas heating element comprises a gas burner.

4. A water heater as set forth in claim 1 wherein the gas heating element comprises a single gas burner.

5. A water heater as set forth in claim 1 wherein the water heater further comprises one or more gas manifolds comprising a first passageway to deliver gas to the first combustive section and a second passageway to deliver gas to the second combustive section.

6 A water heater as set forth in claim 5 wherein the one or more gas manifolds is a single gas manifold.

7. A water heater as set forth in claim 1 and further comprising a valve connectable to a gas source and connected to the first and second combustive sections, the valve adapted to control a first gas flow to the first combustive section and control a second gas flow to the second combustive section.

8. A water heater as set forth in claim 1 wherein the water heater further comprises a valve comprising an inlet to receive gas from a source, a valve spool connected to the inlet, and first and second outlet passageways connected to the combustive sections, respectively, and wherein the valve spool controls at least a portion of the gas to the first outlet passageway and to control at least a portion of the gas to the second outlet passageway.

9. A water heater as set forth in claim 8 wherein the water heater further comprises one or more gas manifolds including a first manifold passageway to deliver gas from the first outlet passageway to the first combustive chamber and a second manifold passageway to deliver gas from the second outlet passage way to the second combustive chamber.

10. A water heater as set forth in claim 8 wherein the valve comprises a multiport outlet including a first port connected to the first manifold passageway and a second port connected to the second passageway.

11. A water heater as set forth in claim 9 wherein the valve spool includes a shaft, wherein the valve further includes a motor connected to the shaft to control movement of the shaft and a controller coupled to the motor to control the motor.

12. A water heater as set forth in claim 11 wherein the motor is a linear force motor.

13. A water heater as set forth in claim 1 and further comprising a single ignition to light the first and second combustive sections.

14. A water heater as set forth in claim 1 and further comprising a single pilot light to light the first and second combustive sections.

15. A water heater as set forth in claim 1 and further comprising

a first valve connectable to a gas source and connected to the first combustive section, the valve adapted to control a first gas flow to the first combustive section;

a second valve connectable to the gas source and connected to the second combustive section, the valve adapted to control a second gas flow to the second combustive section.

16. A water heater as set forth in claim 15 and wherein the water heater further comprises one or more gas manifolds including a first passageway to deliver gas from the first valve to the first combustive chamber and a second passageway to deliver gas from the valve to the second combustive chamber.

17. A water heater as set forth in claim 15 and further comprising a controller connected to the first and second valves to control the valves, thereby controlling the gas flow to the first and second combustive sections.

18. A storage-type water heater comprising:

a water tank;

at least one water temperature sensor operable to sense a water temperature;

a combustion chamber having a thermal relation to the water tank;

a gas heating element disposed in the combustion chamber;

a valve connectable to a gas source and connected to the gas heating element; and

a controller in communication with the valve and the temperature sensor, the controller being operable to receive the sensed temperature, to determine a ratio of the maximum amount of fuel deliverable to the heating element over a time period based on the sensed temperature, the ratio being determined from a plurality of available ratios including a ratio between zero and one hundred percent, and to selectively generate a control signal to control the valve based on the determination.

19. A water heater as set forth in claim 18 wherein a first available ratio is one hundred percent and a second available ratio is zero percent.

20. A water heater as set forth in claim 18 wherein the time period is an instantaneous time period.

21. A water heater as set forth in claim 18 wherein the controller includes a processor and a memory, wherein the memory comprises a heating strategy including at least two conditions, each condition specifying a respective available ratio, and wherein the processor receives the sensed temperature, determines the ratio of the maximum amount of fuel deliverable to the heating element based on the heating strategy and the sensed temperature, and selectively generate the control signal.

22. A water heater as set forth in claim 21 wherein a first condition includes a first temperature range and a second condition includes a second temperature range, and wherein the processor determines the ratio by being further operable to determine whether the sensed temperature is within the first temperature range.

23. A water heater as set forth in claim 21 wherein a first condition includes a first state of the water heater and wherein a second condition includes a second state of the water heater.

24. A water heater as set forth in claim 23 wherein the first state is a draw-down state and the second state is a recovery state.

25. A water heater as set forth in claim 21 wherein the at least two conditions include one or more temperature ranges and one or more states.

26. A water heater as set forth in claim 25 wherein the one or more temperature ranges is a subset of the one or more states.

27. A water heater as set forth in claim 21 wherein the processor determines the ratio based on a plurality of sensed temperature values.

28. A water heater as set forth in claim 27 wherein the first condition includes a first state of the water heater, wherein the second condition includes a second state of the water heater, wherein the processor determines the ratio by being further operable to determine a current water heater state based on the plurality of sensed temperature values and determine whether the current water heater state is within the first state.

29. A water heater as set forth in claim 27 wherein the first state is a draw-down state and the second state is a recovery state.

30. A water heater as set forth in claim 27 wherein the first state includes a first temperature range and the second state includes a second temperature range.

31. A water heater as set forth in claim 27 further comprising a second temperature sensor operable to sense a second temperature, wherein the processor is further operable to receive the second sensed temperature, and wherein the processor determines the ratio further based on the second sensed temperature.

32. A water heater as set forth in claim 31 wherein the second temperature sensor senses an ambient temperature.

33. A water heater as set forth in claim 31 wherein the second temperature sensor senses a second temperature having a relation to a second temperature of the water in the tank.

34. A water heater as set forth in claim 21 wherein the memory further includes a usage pattern, wherein the processor is further operable to develop the usage pattern based on the sensed temperature, and wherein the processor determines the ratio further based on the usage pattern.

35. A water heater as set forth in claim 21 wherein the memory further includes a water use history, wherein the processor is further operable to develop the water use history based on the sensed temperature, and wherein the controller determines the ratio further based on the water use history.

36. A water heater as set forth in claim 18 wherein the heating element comprises a gas burner.

37. A water heater as set forth in claim 18 wherein the heating element comprises a combustive section of a multi-section gas-burner.

38. A water heater as set forth in claim 18 wherein the control signal controls the valve to deliver fuel in bursts.

39. A water heater as set forth in claim 38 wherein each available ratio defines a duty cycle and wherein the controller determines the ratio by being further operable to determine the duty cycle for the bursts based on the water temperature.

40. A water heater as set forth in claim 21 wherein the memory further includes a plurality of stored water heating codes, wherein a first water heating code relates to the heating strategy and a second water heating code relates to a second heating strategy, wherein the processor determines the ratio by being further operable to select a water heater code, and obtaining a heating strategy from the memory with the selected water heater code.

41. A method of controlling a temperature of water in a storage-type water heater, the storage-type water heater including a tank for storing water, a gas heating element to heat the stored water, a valve connectable to a fuel source and connected to the gas heating element, and a controller adapted to control the valve, the method comprising the acts of:

sensing a temperature of the water;

determining a ratio of the maximum amount of fuel deliverable to the heating element over a time period based on a sensed water temperature, the ratio being determined from a plurality of available ratios including a ratio between zero and one hundred percent; and

controlling the valve to issue an amount of fuel corresponding to the determined ratio.

42. A method as set forth in claim 41 wherein a first available ratio is one hundred percent and a second available ratio is zero percent.

43. A method as set forth in claim 41 wherein the time period is an instantaneous time period.

44. A method as set forth in claim 41 wherein the method further comprises implementing a heating strategy, the heating strategy including at least two conditions, each condition specifying a respective available ratio, and wherein the determining act is further based on the heating strategy.

45. A method as set forth in claim 44 wherein the determining act includes determining a condition of the water heater and selecting the ratio based on the determined condition.

46. A method as set forth in claim 44 wherein the heating strategy is based on at least one of an element characteristic and a tank characteristic.

47. A method as set forth in claim 44 wherein the controller comprises a memory including a table having a plurality of stored water heater codes and respective stored strategies, and wherein the method further comprises the acts of

providing a water heater code; and

obtaining the heating strategy from the table with the water heater code.

48. A method as set forth in claim 44 wherein a first condition includes a first temperature range and a second condition includes a second temperature range, and wherein the determining act includes determining whether the water temperature is within the first temperature range.

49. A method as set forth in claim 44 wherein a first condition includes a first state of the water heater and wherein a second condition includes a second state of the water heater.

50. A method as set forth in claim 49 wherein the first state is a draw-down state and the second state is a recovery state.

51. A method as set forth in claim 41 wherein the method further comprises sensing a second temperature of the water in the tank, and wherein the determining act is further based on the second temperature.

52. A method as set forth in claim 51 wherein the first temperature is sensed by a first sensor and wherein the second temperature is sensed by a second sensor.

53. A method as set forth in claim 51 wherein the second temperature is sensed after the first temperature.

54. A method as set forth in claim 53 wherein the method further comprises calculating a slope of a line based on the first and second temperatures, wherein the calculated slope signifies a water heater state, and wherein the determining act is further based on the water heater state.

55. A method as set forth in claim 53 wherein the method further comprises comparing the first and second temperatures, wherein the comparison signifies a water heater state, and wherein the determining act is further based on the water heater state.

56. A method as set forth in claim 44 wherein the at least two conditions include one or more temperature ranges and one or more states.

57. A method as set forth in claim 56 wherein the one or more temperature ranges is a subset of the one or more states.

58. A method as set forth in claim 41 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a usage pattern; and

wherein the determining act is further based on the usage pattern.

59. A method as set forth in claim 41 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a water use history; and

wherein the determining a ratio act is further based on the water use history.

60. A method as set forth in claim 41 wherein the controlling act includes controlling the valve to deliver fuel in bursts.

61. A method as set forth in claim 60 wherein each available ratio defines a duty cycle for the bursts and wherein the determining act includes determining the duty cycle for the bursts.

62. A method as set forth in claim 41 wherein the method further comprises sensing an ambient temperature and wherein the determining act is further based on the ambient temperature.

63. A water heater comprising:

a tank;

an inlet that adds cold water to the tank;

an outlet that withdraws heated water from the tank;

a water temperature sensor operable to sense a water temperature;

a combustion chamber having a thermal relation to the tank;

a gas heating element disposed in the combustion chamber;

a valve connectable to a gas source and connected to the gas heating element;

a controller in communication with the valve and the temperature sensor, the controller being operable to selectively generate a control signal based on the sensed temperature, the selectively generated control signal controlling the valve to provide fuel to the heating element in bursts, each burst followed by a period during which gas is not supplied to the heating element.

64. A water heater as set forth in claim 63 wherein the heating element comprises a gas burner.

65. A water heater as set forth in claim 63 wherein the heating element comprises a combustive section of a multi-section gas-burner.

66. A water heater as set forth in claim 63 wherein the heating element comprises a first combustive section and a second combustive section.

67. A water heater as set forth in claim 66 wherein the water heater further comprises one or more gas manifolds comprising a first passageway to deliver fuel to the first combustive section and a second passageway to deliver fuel to the second combustive section.

68. A water heater as set forth in claim 67 wherein the one or more gas manifolds is a single gas manifold.

69. A water heater as set forth in claim 67 wherein the valve comprises a multiport outlet including a first port connected to the first passageway and a second port connected to the second passageway.

70. A water heater as set forth in claim 67 wherein the valve comprises an inlet to receive fuel from a source, a valve spool connected to the inlet, and first and second outlet passageways connected to the first and second manifold passageways, respectively.

71. A water heater as set forth in claim 66 wherein the selectively generated control signal controls the valve to provide fuel to the first combustive section in a first set of bursts and to provide fuel to the second combustive section in a second set of bursts.

72. A water heater as set forth in claim 71 wherein the first and second sets of bursts are concurrent.

73. A water heater as set forth in claim 71 wherein the first and second sets of bursts are variable.

74. A water heater as set forth in claim 66 wherein the first combustive section comprises a first gas burner and the second combustive section comprises a second gas burner.

75. A water heater as set forth in claim 66 wherein the gas heating element comprises a single gas burner.

76. A water heater as set forth in claim 63 wherein the gas heating element includes a first combustive section and a second combustive section, wherein the valve comprises a first valve connectable to the fuel source and connected to the first combustive section, wherein the water heater further comprises a second valve connectable to the fuel source and connected to the second combustive section, wherein the controller is in further communication with the second valve, wherein the selectively generated control signal controlling the valve controls the first valve to provide fuel to the first combustive chamber in bursts, wherein the controller is further operable to selectively generate a second control signal based on the sensed temperature, the selectively generated second control signal controlling the second valve to provide fuel to the second combustive section in bursts, each burst followed by a period during which fuel is not supplied to the heating element.

77. A water heater as set forth in claim 76 wherein the bursts of fuel provided to the first combustive chamber is concurrent with bursts of fuel provided to the second combustive chamber.

78. A water heater as set forth in claim 76 wherein the bursts of fuel provided to the first and second combustive chambers are variable.

79. A water heater as set forth in claim 76 and wherein the water heater further comprises one or more gas manifolds including a first passageway to deliver fuel from the first valve to the first combustive chamber and a second passageway to deliver fuel from the valve to the second combustive chamber.

80. A water heater as set forth in claim 63 wherein the water heater heats the water to a set point temperature, wherein the controller is a relational temperature controller that controls the bursts based on a relationship between the set point temperature and the sensed temperature.

81. A water heater as set forth in claim 80 wherein the selectively generated control signal controlling the valve decreases the fuel supplied to the heating element as the temperature of the water approaches the set point temperature.

82. A method for controlling a water heater comprising a tank for storing water, a combustion chamber having a thermal relation to the tank, a gas heating element disposed in the combustion chamber, and a valve connectable to a gas source and connected to the gas heating element, said method comprising:

storing water in the water tank so that the water can be heated to a selected temperature during periods of non-use; and

controlling fuel through the valve in bursts, each burst of fuel followed by a period during which fuel is not provided to the heating element.

83. A method as set forth in claim 82 wherein the controlling act comprises:

sensing a temperature of the water;

determining a ratio of the maximum amount of fuel deliverable to the heating element over a time period based on the sensed temperature, the ratio being determined from a plurality of available ratios including a ratio between zero and one hundred percent; and

controlling the valve to deliver an amount of fuel corresponding to the determined ratio.

84. A method as set forth in claim 82 wherein the time period is an instantaneous time period.

85. A method as set forth in claim 83 wherein the method further comprises implementing a heating strategy, the heating strategy including at least two conditions, each condition specifying a respective available ratio, and wherein the determining act is further based on the heating strategy.

86. A method as set forth in claim 85 wherein the determining act includes determining a condition of the water heater and selecting the ratio based on the determined condition.

87. A method as set forth in claim 83 wherein the method further comprises sensing a second temperature of the water in the tank, and wherein the determining act is further based on the second temperature.

88. A method as set forth in claim 83 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a usage pattern; and

wherein the determining act is further based on the usage pattern.

89. A method as set forth in claim 83 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a water use history; and

wherein the determining act is further based on the water use history.

90. A method as set forth in claim 83 wherein each available ratio defines a duty cycle for the bursts and wherein the determining act includes determining the duty cycle for the bursts.

91. A storage-type water heater comprising:

a tank;

an inlet that adds cold water to the tank;

an outlet that withdraws heated water from the tank;

a combustion chamber having a thermal relation to the tank;

a gas heating element disposed in the combustion chamber;

a valve connectable to a gas source and connected to the gas heating element;

a relational temperature controller in communication with the valve and the temperature sensor, the controller selectively generating a control signal based on the sensed temperature, the selectively generated control signal controlling the valve so that only a decreasing portion of fuel is supplied to the heating element as the temperature of the water approaches a set point temperature.

92. A water heater as set forth in claim 91 wherein the selectively generated control signal controls the valve to provide fuel to the heating element in bursts, each burst of fuel followed by a period during which fuel is not provided to the heating element.

93. A water heater as set forth in claim 91 wherein the heating element comprises a gas burner.

94. A water heater as set forth in claim 91 wherein the heating element comprises a combustive section of a multi-section gas-burner.

95. A water heater as set forth in claim 91 wherein the heating element comprises a first combustive section and a second combustive section.

96. A water heater as set forth in claim 95 wherein the water heater further comprises one or more gas manifolds comprising a first passageway to deliver fuel to the first combustive section and a second passageway to deliver fuel to the second combustive section.

97. A water heater as set forth in claim 96 wherein the one or more gas manifolds is a single gas manifold.

98. A water heater as set forth in claim 96 wherein the valve comprises a multiport outlet including a first port connected to the first passageway and a second port connected to the second passageway.

99. A water heater as set forth in claim 96 wherein the valve comprises an inlet to receive fuel from a source, a valve spool connected to the inlet, and first and second outlet passageways connected to the first and second manifold passageways, respectively.

100. A water heater as set forth in claim 95 wherein the selectively generated control signal controls the valve to provide fuel to the first and second combustive sections.

101. A water heater as set forth in claim 95 wherein the first combustive section comprises a first gas burner and the second combustive section comprises a second gas burner.

102. A water heater as set forth in claim 95 wherein the gas heating element comprises a single gas burner.

103. A method of controlling a temperature of water in a storage-type water heater, the storage-type water heater including a tank for storing water and a water temperature sensor, the method comprising the acts of:

storing water in the water tank so that the water can be heated to a selected temperature during periods of non-use;

sensing a temperature of the water;

determining a ratio of the maximum amount of power deliverable by the heating element over a time period based on a sensed water temperature, the ratio being determined from a plurality of available ratios including a ratio between zero and one hundred percent; and

delivering power with the heating element based on the determined ratio.

104. A method as set forth in claim 103 wherein the power includes electrical power and the heating element comprises an electrical heating element.

105. A method as set forth in claim 103 wherein the power includes thermal power and the heating element comprises a gas heating element.

106. A method as set forth in claim 105 wherein the gas heating element comprises a gas burner.

107. A method as set forth in claim 105 wherein the heating element comprises a combustive section of a multi-section gas burner.

108. A method as set forth in claim 103 wherein the method further comprises implementing a heating strategy, the heating strategy including at least two conditions, each condition specifying a respective available ratio, and wherein the determining act is further based on the heating strategy.

109. A method as set forth in claim 108 wherein the determining act includes determining a condition of the water heater and selecting the ratio based on the determined condition.

110. A method as set forth in claim 103 wherein the method further comprises sensing a second temperature of the water in the tank, and wherein the determining act is further based on the second temperature.

111. A method as set forth in claim 103 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a usage pattern; and

wherein the determining act is further based on the usage pattern.

112. A method as set forth in claim 103 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a water use history; and

wherein the determining act is further based on the water use history.

113. A method as set forth in claim 103 wherein each available ratio defines a duty cycle, and wherein the delivering act includes repeatedly bursting an amount of power, each burst followed by a period during which power is not delivered, thereby resulting in the duty cycle.

114. A method as set forth in claim 103 wherein the time period is an instantaneous time period.

115. A method of controlling a temperature of water in a storage-type water heater, the storage-type water heater including a tank for storing water and a water temperature sensor, the method comprising the acts of:

storing water in the water tank so that the water can be heated to a selected temperature during periods of non-use;

sensing a temperature of the water;

determining a ratio of the maximum amount of energy deliverable to the heating element over a time period based on a sensed water temperature, the ratio being determined from a plurality of available ratios including a ratio between zero and one hundred percent; and

delivering energy to the heating element based on the determined ratio.

116. A method as set forth in claim 115 wherein the energy includes electrical energy and the heating element comprises an electrical heating element.

117. A method as set forth in claim 115 wherein the energy includes thermal energy and the heating element comprises a gas heating element.

118. A method as set forth in claim 117 wherein the energy is a fuel.

119. A method as set forth in claim 117 wherein the gas heating element comprises a gas burner.

120. A method as set forth in claim 117 wherein the heating element comprises a combustive section of a multi-section gas burner.

121. A method as set forth in claim 115 wherein the method further comprises implementing a heating strategy, the heating strategy including at least two conditions, each condition specifying a respective available ratio, and wherein the determining act is further based on the heating strategy.

122. A method as set forth in claim 121 wherein the determining act includes determining a condition of the water heater and selecting the ratio based on the determined condition.

123. A method as set forth in claim 115 wherein the method further comprises sensing a second temperature of the water in the tank, and wherein the determining act is further based on the second temperature.

124. A method as set forth in claim 115 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a usage pattern; and

wherein the determining act is further based on the usage pattern.

125. A method as set forth in claim 115 and further comprising:

repeating the act of sensing a temperature of the water;

storing multiple sensed temperatures, the storing act resulting in a water use history; and

wherein the determining act is further based on the water use history.

126. A method as set forth in claim 115 wherein each available ratio defines a duty cycle, and wherein the delivering act includes repeatedly bursting an amount of energy, each burst followed by a period during which energy is not delivered, thereby resulting in the duty cycle.

127. A method as set forth in claim 115 wherein the time period is an instantaneous time period.